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Robert A. Taft Sanitary Engineering Center
Cincinnati, Ohio

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Samples of the Jefferson City, Missouri, raw and finished water were passed through carbon filters and the contents analyzed for contaminants that may affect taste and odor. Approximately 25 parts per billion of chloroform extractable materials were recovered from both the raw and finished water. Chlorination had little influence on the taste and odor effects. Chemical examination coupled with the taste and odor tests indicated that the odorous materials were of petroleum origin. It was conjectured that treatment at the water plant to specifically remove these materials would materially reduce the taste and odor.

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SUMMARY

Samples of the Jefferson City, Missouri raw and finished water were passed through carbon filters and the contents were analyzed for contaminants which may affect taste and odor in these waters. Collection was made on December 18 and 19, 1956.

Approximately 25 parts per billion of chloroform extractable materials were recovered from both the raw and finished water. The threshold concentration of the extract from the finished water as labeled was 1 p.p.b, indicating the presence of very odorous substances. Chlorination of the materials had little influence on the taste and odor effects.

Chemical examination coupled with the taste and odor tests indicated that the odorous materials were of petroleum origin. The taste and odor appeared to be concentrated in the aromatic and oxygenated components of the neutral materials. Part of the odor may have been due to the hydrocarbon as such with an additional amount due to complex oxidation products.

It is conjectured that treatment at the water plant to specifically remove these materials would materially reduce the taste and odor.

ORGANIC COMPONENTS RECOVERED FROM JEFFERSON CITY, MISSOURI RAW AND FINISHED WATER

Background

Cities using the Missouri River as a source of water supply have had periodic difficulties from taste and odor. Carbon filters which were on hand in the area were placed on the Jefferson City raw and finished water in an attempt to obtain samples of the organic contaminants which may be responsible for the difficulties. Four thousand nine hundred gallons of raw water were passed through the carbon filter from December 18 at noon to 1 p.m. on December 19, 1956. Two thousand gallons of finished water were filtered from 8:00 a.m. to 1:30 p.m. on December 19*.

Laboratory Results

The carbon from the filters is first extracted with chloroform; this is followed with an alcohol extraction. The chloroform extractable materials are the more significant as possible causes of taste and odor. These materials are separated into several fractions. The following table shows the quantities of materials recovered and the results of the group separation.

* The volumes filtered and the analysis suggest that a mix-up of raw and finished samples may have occurred since it would be expected that the larger volume of water filtered would be the finished water. Evidence on the odor indicates that more odor is present in the "finished" water which also is somewhat anomalous since phenolics are not believed to be involved. The rates of filtration on this sampling run are much higher (approximately 3 gal/min. for raw water) than those normally used. (Normal rate 1/4 to 1/2 g.p.m.). This would tend to give low results on total materials present since inadequate adsorption time was permitted.

RECOVERY AND SEPARATION OF ORGANICS FROM JEFFERSON CITY WATER

	Raw		Finished	
Gallons Filtered	4,900		2,000	
Quantities Recovered	Grams	ppb	Grams	ppb
Chloroform	0.44	24	0.19	25
Alcohol	0.73	39	0.83	109

Groups from Chloroform Extracts	Raw	Finished
	parts per billion	
Ether Insolubles	0.2	0.0
Water Solubles	4.0	1.0
Weak Acids	1.0	1.0
Strong Acids	1.0	0.3
Bases	0.5	0.3
Neutrals	13.0	17.0
Loss	5.0	5.0
Aliphatics*	3.0	4.0
Aromatics	0.3	3.0
Oxys	7.0	6.0
Loss	2.0	4.0

The odor of the chloroform extracts resembled hydrocarbons. At one dilution it was kerosene-like and in stronger concentrations resembled used oil. The alcohol extracts consisted of dark, waxy materials with an odor of burnt sugar. The chloroform extract consisted of two layers of organic materials. The top layer was oily; the bottom was waxy. The larger amount of oil was in the "finished" sample (recall note that samples may have been mislabeled when sent in) and this sample was most odorous.

* The aliphatics, aromatics and oxys are fractions of the neutral group.

Threshold taste and odor tests were made on the chloroform and alcohol extracts. Five or six observers were presented dilutions of these materials in odor free water along with appropriately spaced blanks. The first dilution detected was recorded as the threshold for that observer and a geometric mean was taken of all the observations on a particular sample. The results were:

THRESHOLD VALUES PARTS PER BILLION

	Chloroform Extract		Alcohol Extract	
Source	Taste	Odor	Taste	Odor
Raw	44	25	79	72
Finished	16	1	4000+	128

From this data it appears that the taste and odor are most significant in the "finished" water. Furthermore the fact that 1 p.p.b. of the material can be detected is evidence that the odorant is a powerful one. Since at least 25 p.p.b. of the material are present considerable odor potential would be expected in this water. The alcohol extract does not appear to contain materials of significance to taste and odor.

Marginal chlorination may cause a substantial increase in taste and odor intensity of water particularly if phenolic materials are present. The extracts from the raw water were tested for this effect by the preparation of dilutions of the chloroform and alcohol soluble materials. These dilutions were chlorinated in a stepwise manner so that residuals varied from 0.1 to 1.0 p.p.m. Taste and odor tests after both short and

long contact times did not reveal any substantial change from the unchlorinated materials. The alcohol soluble materials did exhibit a break-point reaction in the chlorination series.

Nature of the Materials

Reference to the table of group separations indicates that the neutral materials were the most abundant. The oily nature of the extracts further supports this finding since the hydrocarbon materials are in the neutral group. The neutrals, in addition, had an intense odor. Separation of the "finished" water neutral extract by chromatography revealed that the 17 p.p.b. of material consisted of; aliphatics 4 ppb, aromatics 3 ppb, oxygenated materials 6 ppb and unrecoverable material 4 ppb. The aliphatics had relatively low odor intensities, the aromatics were more intense and the oxys were very odorous. It is concluded that the bulk of the odor resided in the aromatic and oxy fractions. It is further concluded that these materials were of petroleum origin and that the odor was due to both the original materials and oxidized substances.

Discussion

Based on these observations, it would appear that measures to reduce oily contaminants in this water would improve the the quality and taste and odor characteristics. Chlorination did not appear to either increase or decrease the taste and odor intensity hence large scale use would not appear warranted for the control of these materials. It should, of course, be ascertained at the plant on the water as received whether this premise is true or whether materials missed by the filter are a critical factor in regard to chlorination.

Oily materials should be partially removed by coagulation and effective sand filtration. Application of activated carbon in suitable amounts should further reduce the contaminants.

Respectfully submitted

F. M. Middleton

F. M. Middleton
March 18, 1957